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ABSTRACT

This document contains five symposium papers exploring sex differences in cognition. The first paper defines the purposes of the study, i.e., to examine which cognitive performance factors are related to sex differences, and to investigate possible biological, social, and psychological factors affecting developmental sex differences. The second paper reports research results indicating that scores on a physical mathematical reasoning measure are related to spatial ability group and that sex differences in ego development exist. The third paper discusses the research finding that some affective parent behaviors are related to spatial ability groups. The absence of differential parental socialization of boys compared to girls is also discussed. The fourth paper focuses on the lack of evidence that sex-typed activities of the adolescent sample are related to spatial ability groups. The final paper presents the finding that later maturation is related to higher spatial ability and notes that this effect did not appear to operate through brain lateralization. The document concludes with a brief overview of the future research steps. (NRB)

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SEX DIFFERENCES IN COGNITION: Exploring Alternative Explanations

Symposium Papers

by

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Paper presented at the Annual Convention of the American Psychological Association, Montreal, September 1980.

We gratefully acknowledge the Spencer Foundation for support of this research.

During the decade of the 1970's there was a great deal of interest and activity focussed on the topic of sex-related differences in cognitive performance. The conceptual and methodological problems with past research in this area were described and new approaches were suggested (e.g., Maccoby & Jacklin, 1974; Wittig & Petersen, 1979). Some exciting research programs are underway and the preliminary results are promising.

Where we have been less successful, however, is with integrating the perspectives taken in conducting this research. Maccoby and Jacklin in their volume as well as Wittig and I in ours stressed the importance of integrating perspectives. Yet, apart from a few researchers, and our discussants today are among them, biological and cultural determinists remain in separate camps. The burst of research in the area of brain lateralization and brain functioning has included much work in sex differences. Indeed, much of this research is motivated by the pursuit of sex differences in the brain, an area about which Psychology Today (11/78) said

"At the moment there is no hotter issue in psychology." The vast majority of brain researchers consider only the biological system when posing their research questions or making inferences from their results, even though their measures are generally performance measures rather than biological ones. That is, they assume that any effects of sex on brain lateralization measures are due to "wired in" mechanisms. Similarly, researchers in the sociocultural camp do not generally consider the biological aspects of cognitive performance when posing their questions or making inferences, even though they often use cognitive measures identical to those used by biological researchers.

The study addresses two questions. First, since cognitive performance is due to ability, strategy, and motivation, we are interested in determining which of these factors are related to sex differences. Second, we are investigating various possible factors that might have produced the sex differences developmentally. Biological, psychological, and social factors are included in our model.

The present study was intended to bridge the gap. Our theoretical perspective is a transactional development one (e.g., Sameroff, 1975). We view capacities such as those leading to cognitive performance as resulting from a transaction among biological and sociocultural factors through the course of development. Specific individual or situational factors may further alter development in an individual. Slide 1 shows this general model in a static sense. Biological factors that have been hypothesized as influencing cognitive performance include genes; prenatal, puber-

tal, and cyclic hormones; timing of maturation; and brain lateralization. As I have noted (Petersen, 1980), most of the explanations for sex differences cognitive performance have been biological. But there are some hypotheses on the sociocultural side: socialization from parents, courses taken, interests and activities. We also consider some psychological factors as possible mediators of other influences; developmental psychological changes, sex role identity, and self esteem, among others. These are shown in Slide 2. Note that family influences are not included in the model; we now feel that this was a major omission but it reflected the state of research at the time we developed the model.

In this symposium, we will report preliminary findings from the broader study in which we assessed factors in each of these areas. The next slides list the constructs in each area. (Slides 3,4, 5, and 6).

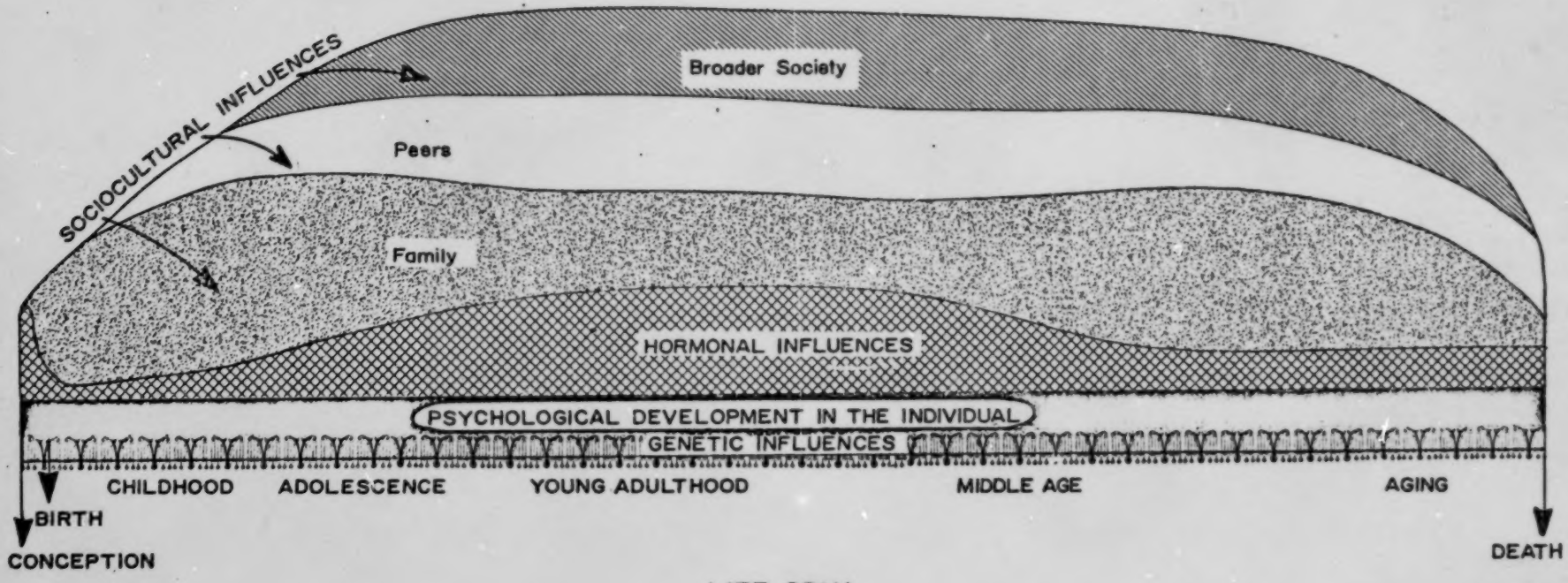
Maccoby and Jacklin (1974) identified three areas consistently showing sex differences beginning in adolescence: mathematics, verbal ability, and spatial ability. For a variety of reasons, we chose to focus on spatial ability as a key construct in our study. This is an area in which boys tend to excell. We measured spatial ability with the Guilford-Zimmerman Clocks test. This test requires a spatial strategy and is very difficult to perform with a verbal strategy. To unconfound spatial ability from sex we sampled subjects in a two by three design within both these strata. This design enables us to aks how sex and spatial ability and their interaction are related to other variables. Slide 7 shows our basic sampling design on subjects. This sampling strategy overselects extremes,

especially high girls and low boys. The subjects for our study were randomly selected within the design strata from among about 500 high school seniors. We chose that age so as to unconfound pubertal developmental influences on the biological and perhaps other measures. The social class of the students ranged from lower-middle to upper-middle class.

Our sampling of subjects produced some very interesting unintended results. We replaced subjects who decided not to participate, or who consented but failed to complete the majority of the assessments. As we approached our deadline for data collection, however, we had exhausted our pool of potential subjects in two cells, high space girls and low space boys, and in other cases had to give up on subjects who were unlikely to finish. Slide 8 shows the distribution of our final sample, consisting of 139 rather than 150 subjects. It is interesting to note that the largest turnover was among boys in the lower spatial ability group. The low space subjects had a difficult time with many of the spatial tests, and the boys were less willing than girls to continue, perhaps exacerbated by the fact that all of the interviewers (the present panel) were women. We suspect that this unwillingness to participate is a complex matter and may be a source of bias in studies with volunteer subjects.

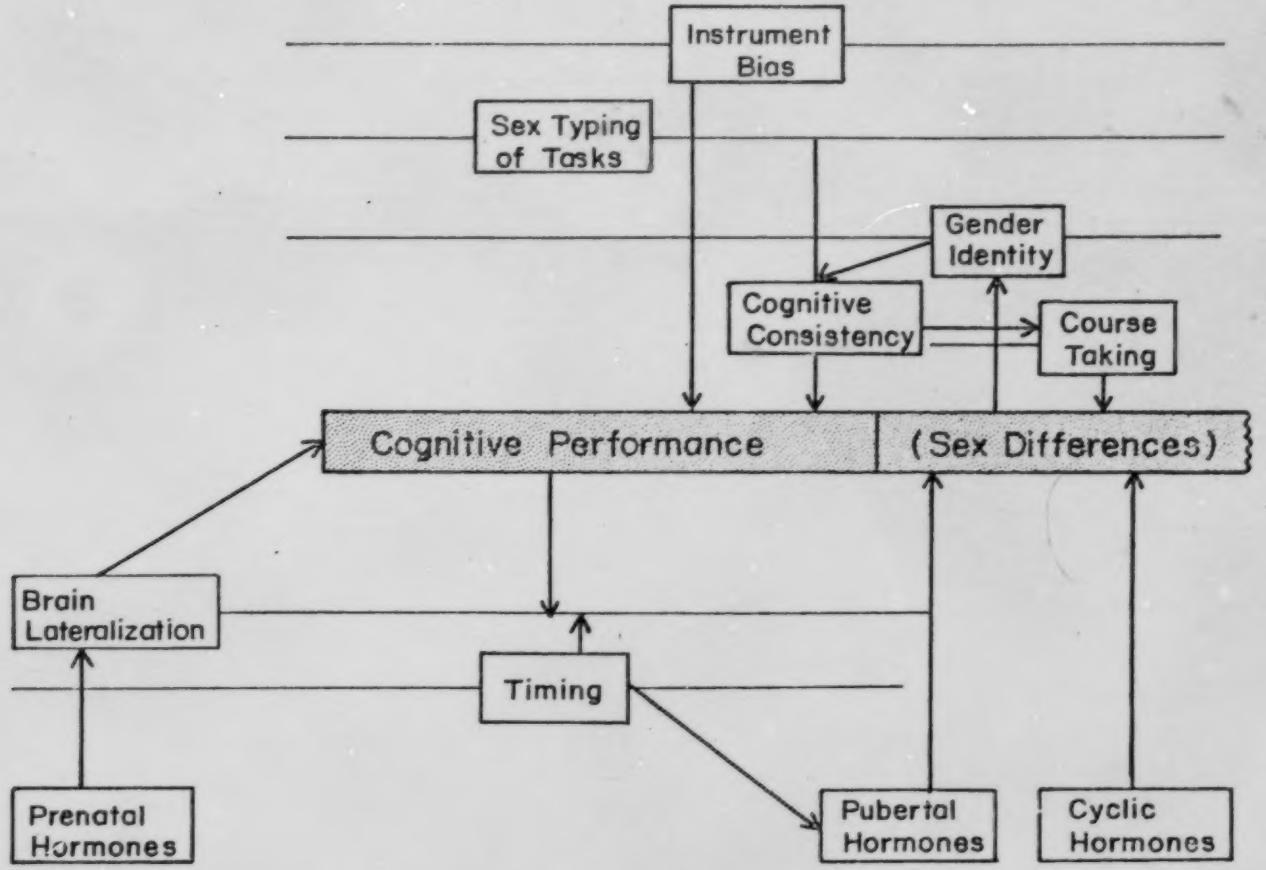
We are studying a large number of contructs in this study but have chosen for this symposium to focus on the primary constructs in each area. Our ultimate goal is to find a model that explains spatial performance in our study. For today's symposium we will use the same an-

alytic design for all the presentations. Sex and spatial ability group are considered as design factors in multivariate analyses of variance. Because we expect linear effects across space groups, we compared the low group with the medium and high groups, respectively, in the two permitted contrasts across the three groups. As background for interpreting any spatial group effects, it is important to know that there are no differences among groups in intelligence among girls, but that there is a significant linear trend among boys. Thus, with boys spatial ability is confounded with general intelligence. We shall discuss this issue more, later; for now, let me just say that we do not consider the result a methodological artifact. This and other information lead us to concluded that spatial ability is more salient as a cognitive component for boys than for girls.


SOCIOCULTURAL INFLUENCES
Broader Society
Peers
Family
HORMONAL INFLUENCES
PSYCHOLOGICAL DEVELOPMENT IN THE INDIVIDUAL
GENETIC INFLUENCES
CHILDHOOD
ADOLESCENCE
YOUNG ADULTHOOD
MIDDLE AGE
AGING
BIRTH
CONCEPTION
DEATH

LIFE SPAN

LEVELS OF INFLUENCES



PHASES OF DEVELOPMENT

SOCIOCULTURAL FACTORS

Family	Configuration (Birth order, sibling sex, etc.) Parent Behavior Form Encouragement of courses, activities
Education	Courses taken, interests, reasons
Activities	Music Athletics Strategy games Hobbies Fraser Activity Scale

COGNITIVE MEASURES

Spatial Ability	Vandenberg Mental Rotations DAT Space Relations Embedded Figures Test Water Level Task
Verbal Ability/ Fluent Production	DAT Clerical Speed & Accuracy DAT Spelling Stroop Color Naming Quick Test
Cognitive Development (Formal Operations)	Linn Balance Test Linn License Plates
Social Cognition	Selman Interpersonal Awareness Interview

PSYCHOLOGICAL FACTORS

Sex Role	Bem Sex Role Inventory (adapted)
Attitudes	Attitudes Toward Women Scale for Adolescents
Self Esteem	Rosenberg Self Esteem Inventory
Ego Development	Loevinger Sentence Completion Test

plus various questions and measures from the individual interview

BIOLOGICAL FACTORS

Brain Lateralization	Dichotic Listening Task (Syllables)
Handedness	Edinburgh Handedness Inventory
Maturation Rate	Age at menarche Age at most rapid growth
Physical Androgyny	Self ratings Interviewer ratings

SAMPLING DESIGN

Spatial Ability Groups[1]

	Low	Middle	High	Totals
Boys	25	25	25	75
Girls	25	25	25	75
Totals	50	50	50	150

[1] measured by the Guilford-Zimmerman Clocks Test.

ACTUAL SAMPLE

Spatial Ability Groups

	Low	Middle	High	Totals
Boys	16	24	27	67
Girls	23	25	24	72
Totals	39	49	51	139

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The Relation of Developmental Variables to Sex Differences in Spatial Ability in Adolescence

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We gratefully acknowledge the support of the Spencer Foundation in this research.

The purpose of this presentation is to consider sex differences and spatial ability in the relationship of psychological and cognitive develoment. Evidence that sex differences in spatial performance emerge in adolescence raises the issue of whether and to what degree these changes in spatial competency are related to psychological and cognitive variables, such as physical-mathematical reasoning, interpersonal reasoning, and ego functioning.

The relationship between physical-mathematical reasoning and sex differences in adolescence has been actively researched. Generally traditional Piaget and Inhelder Tasks have been used to represent the crucial or focal accomplishments of formal operational thinking, that level of operational thinking seen as evolving in the early teen years. The research generally supports the conclusion that males show higher performance skills on a variety of laboratory tasks involving combinatorial thinking, proportionality, reflexivity (Dulit, 1972). These are tasks which are heavily visual-spatial. The nature of these makes it likely that intervening variables, such as spatial ability, may be salient in that apparent sex difference.

We added interpersonal reasoning to our cognitive developmental variables for a number of reasons. First, the construct validity of task-defining formal operations as a series of physical-mathematical problems has been questioned (Elkind, 1975). Cognitive developmental researchers have attempted to link the formal operational construct with an expanded set of cognitive domains. Turiel (1988) has recognized the complexity of

cognitive functioning and has attempted to define separate areas of conceptualization: moral, interpersonal, physical. These domains are conceptually distinct in that they arise out of interaction between organism and environment having differential salience at different points in development. Kohlberg in moral development and Selman in interpersonal or social development have attempted to empirically define additional reasoning domains. The area of interpersonal cognition is of particular interest in our study because of its important implications in the adolescent period and in the consideration of sex differences, in that it allows for potentially differential application of reasoning competencies. As Elkind (1978) notes in his review of recent research in formal operations in adolescence, "Girls, for social role reasons, are more likely to apply their formal operational thinking to interpersonal matters than to matters of science." As in the area of physical-mathematical reasoning, we are interested in the role of spatial ability in this interpersonal domain, particularly in comparing the saliency of spatial competence as opposed to sex in these two cognitive areas.

Our third developmental variable, ego functioning, is of particular interest because of the general assumption held in cognitive-developmental theory that the cognitive domain is the central axis for all development, including social and emotional. Piaget (1967) speaks of the mature individual personality which can only begin to be constructed in adolescence because, "it is dependent on formal thought." This assumption is both theoretically and empirically questionable. If formal thought is essential to social-emotional development, can we assume that non-formal think-

ers, apparently more numerous than originally construed, are emotionally underdeveloped? Furthermore, must we also assume that females are less adequately able to navigate the social-emotional waters of adolescent development because of their apparently poorer formal-operational skills? To explore these questions we selected the construct of ego development because it represents an integration of developmental and social-emotional realms. There has been no investigation of the degree to which spatial ability may be related to ego functioning. Loevinger has characterized ego development as representing a growing capacity for integration of different roles or identities. We are interested in the role that spatial competency may play in this integrative area, and the possibility that spatial ability might have differential saliency for males' ego functioning as compared to females'.

By examining the impact of spatial ability, and by expanding the formal operational construct to include interpersonal reasoning, we hoped to gain insight and empirical evidence as to whether alternative mediators to physical-mathematical reasoning might be more significant in understanding women's cognitive and psychological functioning.

To consider these issues we developed two sets of hypotheses. The first set is concerned with the relationship between two areas of cognitive functioning, specifically physical-mathematical reasoning and interpersonal reasoning, and sex and spatial ability. We predicted 1) that spatial ability would have a significant association with physical-mathematical reasoning due to the nature of the task, and that this association

would hold for males and females; 2) that there is not a significant association between spatial ability and interpersonal reasoning, for either male or females; 3) that sex would not be a significant variable in the domains of interpersonal or physical-mathematical reasoning when spatial ability is controlled for.

The second set of hypotheses was concerned with the relationship between cognitive and ego functioning, and sex and spatial ability. Theorizing that spatial ability is more salient for males than females, we predicted that females would not be affected by spatial ability in their ego functioning, but that males would be. That is, there would be a sex by spatial competency interaction. We further predicted that interpersonal or social cognition would relate significantly to ego functioning for either sex. In these predictions we are suggesting the presence of two sufficiently distinct realms of cognitive functioning in mid-adolescence to have differential impact on the ego functioning of adolescents.

Measures

Interpersonal reasoning was measured using the Selman Interpersonal Awareness Scale, Persons sub-scale. A narrative story was read to each respondent posing a social-interpersonal dilemma. We then asked questions designed to determine subject's level of cognitive functioning in the areas of subjectivity, self-awareness, personality and personality change. Answers were probed in order to reach as high a level of competence in these areas as possible. (The responses were then scored by two independent scorers,

manual-trained, with scoring based on a cognitive-theoretical framework and a set of illustrative responses.) Level of performance was divided into stages, with each of the four areas given a stage score and an average stage score derived through a weighted total of the four issues. Subjects in this sample fell into three levels, 2,3, and 4, or mid-levels, such as 2 (3), or 3 (4). See Table 1 for description of stages. Inter-rater reliability was done on 10% of the protocols, blindly rated. Inter-rater reliability was .86. Inter-issue reliability was at an acceptable level (.48).

A second measure of social cognition, titled Interpersonal Perception, was designed from questions asked on the extensive interview each respondent was given. Ten questions were evaluated to consider three areas: Differentiation, Cue Sensitivity and Complexity. Differentiation involved the ability to infer others' intentions and feelings as different from one's own. Cue Sensitivity involved openness to stimuli which have inferential relevance for the way another is structuring reality, the ability to generalize from moods and feelings as well as words. Complexity was defined as structuring of interpersonal cues into patterns and whole, the ability to organize beyond one or two features, beyond stereotypes. Items were scored on a scale of 1 to 3. A mean score was derived for each scale and a total Interpersonal Perception score was based on the mean of the 3 issues. Inter-issue reliability was at an acceptable level (.53).

Two tests of physical-mathematical reasoning were used, modifications into paper and pencil tests of the Inhelder and Piaget formal operational

tasks of combinatorial thinking and proportionality. One was an illustrated balance beam with multiple-choice questions relating to the necessary weight and placement to achieve balance. The second was a problem of combining four numbers into the maximum number of unduplicated combinations. These measures have been used by Linn (1978) in a series of research projects on content issues in formal operations, and have been highly correlated with the Piaget and Inhelder tasks.

Ego development was measured by the Loevinger Ego Development Scale (1970), a set of 36 sentence stems given to the respondent to complete. These were administered individually. Scoring was done by trained scorers. Reliability was measured against correlations with the manual appendices and was at the .82 level. In addition inter-rater reliability reached a high level (.88). Completed sentences were scored on a scale of 1-levels or ego levels, which are described in Table 2.

Results

A multivariate analysis was used, with three levels of spatial ability and sex as the independent variables and ego functioning, two forms of interpersonal reasoning, and two forms of physical-mathematical reasoning as dependent variables.

Space Group Effects

The multivariate test of effects revealed space group to contribute significantly to the variance ($p. < .00$). A univariate breakdown indicated

that this effect was exclusively in the area of physical-mathematical reasoning: proportionality ($p. < .00$). (See Table 1.) Space group made no significant contribution to the mean differences in ego functioning or interpersonal awareness. (See Tables 2 & 4).

Sex Effects

Sex was a significant contributor in the model ($p. < .00$). The univariate breakdown revealed that the sex effect was significant only in the relationship with ego functioning ($p. < .00$). (See Table 2). There was a significant interaction between space group and sex ($p. < .01$). The univariate analysis revealed the interaction was significant only in its association with interpersonal perception, specific to the interview data. (See Table 3). The interaction between space group and sex was not significant in interpersonal reasoning (Selman), ego functioning, or physical-mathematical reasoning. Slides 1, 2 and 3 represent the significant effects based on cell means.

In summary, results of the MANOVA showed significant effects of space group on physical-mathematical reasoning only, of sex on ego functioning only, and of space group by sex on Interpersonal Perception only. Neither sex nor spatial ability contributed significantly to Interpersonal Awareness.

We also examined the association between dependent variables. Ego functioning was significantly correlated with interpersonal reasoning for both males ($r=.34$) and females ($r=.26$). Ego functioning was not correlated

with interpersonal perception (interview data) for males (r=.00), but was for females (r=.39).

The relationship between ego functioning and physical-mathematical reasoning depended on the measure used. The proportionality (balance beam) task did not correlate with ego functioning for either males or females. However, the combinatorial thinking (license plate) task did correlate with ego functioning for males ($r=.30$, $p.<.006$), but not for females.

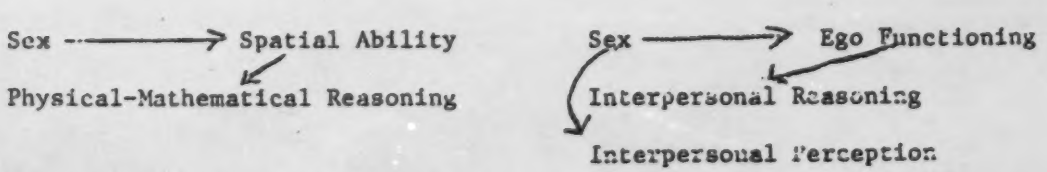
The correlations between interpersonal reasoning and physical-mathematical reasoning were small (proportionality, r=.17; combinatorial thinking, r=.05), suggesting that these two domains are distinctly separated from each other in this study.

Discussion

The conceptual and empirical separateness of the two cognitive domains, physical-mathematical and interpersonal, seems well supported in our data. Spatial ability, across sex, is a significant contributor to physical mathematical reasoning, but has no significant association with interpersonal reasoning. In contrast, sex differences are not important in either area. This is likely to be a function of the sample, chosen to contain an equal representation of males and females in spatial ability groups, thus reducing a sex effect. Nevertheless, it is supportive evidence that, as predicted, spatial ability and not sex is a major factor in physical-mathematical reasoning. The absence of sex or spatial ability as a significant

variable in interpersonal reasoning suggests the presence of other salient variables in this domain, and leads to consideration of the more experientially-linked variable of ego functioning. The significant relationship between interpersonal reasoning and ego functioning may indicate that this is the salient connection between cognitive and personality development at this point in development. If indeed formal operational structures are essential to adolescent emotional and social adaptation, it is in the area of interpersonal or social cognition that these structures are expressed. The absence of an interaction with sex further suggests the saliency of social cognition as a mediator of personality issues for both males and females.

The single hypothesis not supported was the predicted relationship between spatial groups and ego functioning in males. There was no sex x space group interaction in ego functioning. The only two significant ego functioning relationships were with sex and interpersonal reasoning. The relevance of sex, and not space group, in ego functioning, in contrast to the saliency of space group and not sex in physical-mathematic reasoning serves to point to the different areas in which sex and spatial ability are salient. We can now further explore the possibility that sex differences are an artifact of spatial ability in the area of physical-mathematical reasoning, but that ego functioning is the salient variable in the relationship between sex and interpersonal reasoning. A graphic model of the transactions we have posited is as follows:



the highly significant relationship between sex and ego functioning needs further investigation. This relationship is not clearly supported in the ego development literature, and may be specific to this particular age group. The low correlation between the two measures of physical-mathematical reasoning is also puzzling, and alternative scoring of the license plates task will be attempted. Another uncertain relationship is that between the two measures of interpersonal reasoning, with the low correlations between them suggesting that the Selman task may be a more refined cognitive reasoning task, while other social factors are at play in the interview data.

Given the nature of our analysis, we cannot make any assumptions regarding the direction of causality. However, the arrows suggest that further analysis should explore issues of directionality in the role of spatial ability and ego functioning in cognitive developmental domains. Our data confirm the complexity of the relationships we are exploring, and the need to analyze the mediating factors in sex differences, and in subsequent analysis, the causal nature of the relationships.

Table 1

Means and Standard Deviations for Physical-Mathematical Reasoning by Sex and Space Groups

		Space Groups		
		Low	Med	High
Sex:	Male	6.50 (2.03)	7.27 (3.02)	10.04 (2.78)
	Female	6.13 (2.99)	7.44 (2.48)	8.67 (3.31)

Scale: 13 items - Means based on total correct.

Table 2

Means and Standard Deviations for Ego Functioning by Sex and Space Groups

		Space Groups		
		Low	Med	High
Sex:	Male	4.25 (1.53)	4.00 (1.55)	5.26 (.94)
	Female	5.48 (1.27)	5.72 (1.28)	5.54 (1.02)

Scale: Means from 4.00 to 5.00 represent I-Level 3.
Means from 5.00 to 6.00 represent I-Level 3/4.

I-Level 3: Conformist, conforming to external rules, shame, guilt, belonging, reflecting superficical niceness, pre-occupied with appearance and social acceptability, conceptually stereotypic.

I-Level 3/4: Conscientious-Conformist, developing differentiation of norms, aware of self in relation to group, pre-occupied with adjustment problems and vague opportunities.

I-Level 4: Conscientious, self-critical, guilty regarding consequences, setting up self-evaluated standards, intensive, responsive, concerned for communication, with differentiated feelings, preoccupied with achievements and expression.

Table 3

Means and Standard Deviations for Interpersonal Perception by Sex and Space Groups

		Space Groups		
		Low	Med	High
Sex:	Male	2.08 (.29)	2.05 (.27)	1.89 (.32)
	Female	1.89 (.33)	1.96 (.31)	2.06 (.28)

Scale: 1 - Low level of differentiation, cue sensitivity and complexity. No recognition of differing points of view between parents, and parents and self. No awareness of parents' past interests of current attitudes toward self. Stereotypic responses toward current issues.

2 - Some differentiation, cue sensitivity and complexity.

3 - High levels of above.

Table 4

Means and Standard Deviations for Interpersonal Awareness by Sex and Space Groups

Interpersonal Awareness/Selman

		Space Groups		
		Low	Med	High
Sex:	Male	2.62 (.42)	2.66 (.33)	2.78 (.31)
	Female	2.61 (.27)	2.84 (.30)	2.65 (.36)

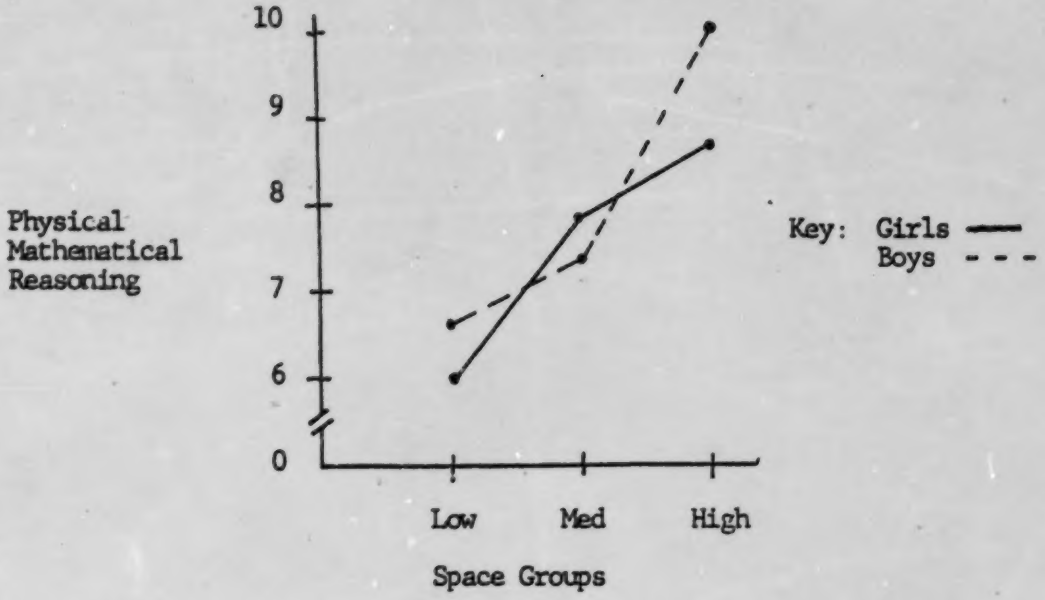
Scale 1: Means directly represent Interpersonal Awareness Levels.

Level 1: International subject, recognizing covert can underly overt, more than one feeling toward different objects possible, can't hide what one feels, personality equivalent to skill.

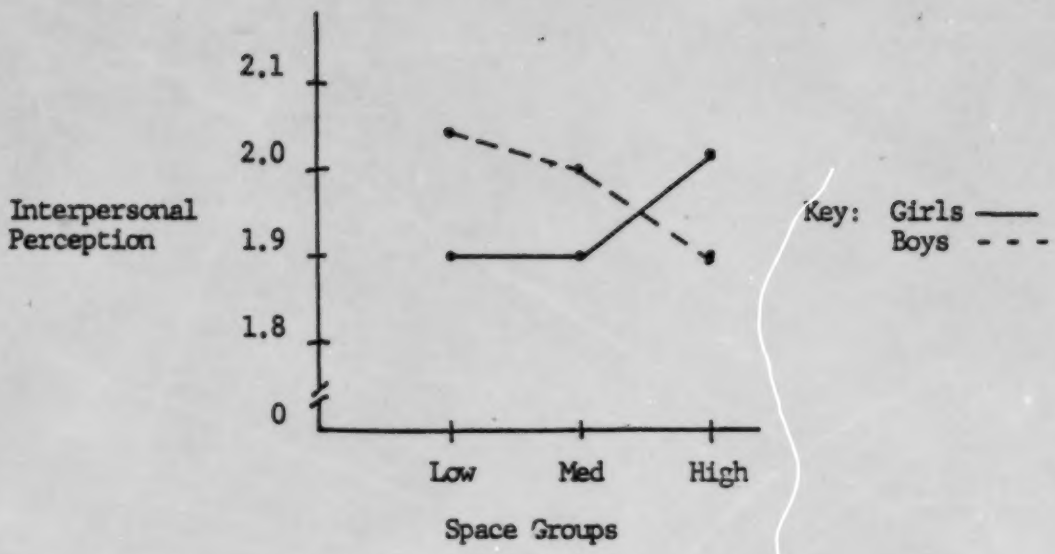
Level 2: Introspective, recognizing inner/outer distinction but with little complexity, feelings being covered up readily and personality a function of action and motives.

Level 3: Stable, feelings changing in stages and a view of a generalized personality.

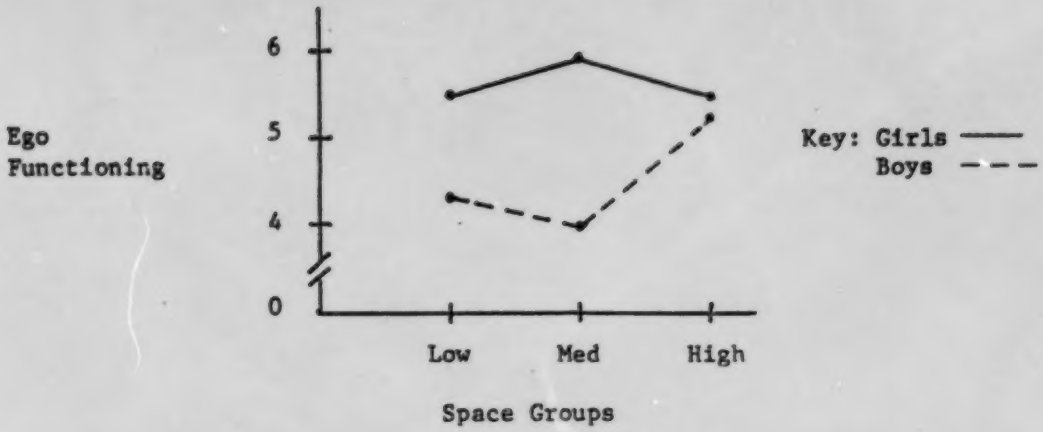
Level 4: Complex self-system, awareness of a core temperament, synthesized feelings, unconscious motives



Mean Physical Mathematical Reasoning scores for males and females by space group. Scale ranges from 1 to 13, 13 representing highest possible score.



Mean Interpersonal Perception scores for males and females by Space group. Scale ranges from 1 to 3, 3 representing highest level of interpersonal perception.



Mean Ego Functioning scores for males and females by Space group. Scale ranges from 2 to 6, 6 representing highest level of ego functioning.

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The Relationship of Parenting Behavior to Adolescents' Sex and Spatial Ability

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We gratefully acknowledge the support of the Spencer Foundation for this research.

Within the context of this larger research project, I was particularly interested in investigating the relationship among sex, spatial ability and the parenting behaviors our adolescents experience. While the study of child-rearing practices has had an extensive and rich tradition within our discipline, relatively little attention has been paid to the ways in which parents may respond differentially to male and female adolescents. Maccoby and Jacklin (1974) underscore the need for research in this area in their critique of much of the socialization research that has tried to understand sex-related differences. They stress that the large majority of studies have been done with preschool-aged children and attribute this sampling bias to two implicit assumptions made by developmental psychologists. On the one hand, the influence of parents is assumed to decline with age as teachers and peers become more salient models and reinforcing agents. The second assumption they point to pertains to the important role assigned to identification as the major process of sex-role socialization. Whether viewed from psychoanalytic viewpoint or a cognitive developmental perspective, identification is often considered to be a static process accomplished in the first three to five years of life. Maccoby and Jacklin point out that a Skinnerian view would argue that there is no reason why external contingencies should not continue to shape and reshape the individual: "this view would not point to any developmental change in the relevance of external socialization forces (p. 305)."

It is not my intention to evaluate the theories of early sex-role development, but rather to emphasize the need for looking at parenting during the adolescent years. While I would expect that in a well-executed

longitudinal study, we would find stability within parenting styles across time, it is important to know how adolescents are experiencing their parents during the years when sex-related differences in spatial ability become apparent. Thus, we included parenting behavior as one of the sociocultural factors in the model guiding our larger study. It is our expectation that parenting will influence the adolescent sex-role identity as well as relate directly to their performance on measures of spatial ability.

The design of this study (described previously) allows us to investigate how an adolescent's perception of parenting behavior varies as a function of the sex of the adolescent, his or her level of spatial ability as well as the sex of the parent. Although the child-rearing literature provides us with clues as to how these variables may relate, relatively little attention has been paid to the degree to which parental encouragement of cognitive behaviors relates to subsequent performance (Kelly & Worrell, 1976). Morrow and Wilson (1961) found that high achieving male high school students reported more frequent parental "sharing of ideas and activities," encouragement of achievement, less strictness and greater affection than lower achievers. Kelly and Worrell (1976) investigated the relationships between reported parental childrearing practices and the achievement (ACT scores) of college students. Their correlational analyses revealed that ACT scores were principally related to parental cognitive behaviors (i.e., the parent's encouragement of intellectual independence, competence and curiosity) for both males and females. Furthermore, it appeared that the behavior of the same-sex parent was more salient than the opposite-sex parent.

In a review of the research carried out on parent-child relationships

in the sixties (Walters & Stinnett, 1971), differences in parental influence according to sex of child are described briefly as are the differential effects of parents of each sex. They summarize the findings in the former category by pointing out that various studies have suggested that boys are more susceptible than are girls to potential influence. In the latter category they review Emmerich's (1962) finding that mothers were generally more nurturant than fathers as well as Rothbart and Maccoby's (1966) finding that parents respond more permissively to opposite-sex children.

The relevance of understanding how parenting behavior relates to spatial ability is pointed out by Nash (1979) in her discussion of sex-role as a mediator of intellectual functioning. The cross-cultural evidence regarding the parental antecedents of spatial ability are fairly consistent. It appears that field independence is related to permissiveness in child-rearing while field dependence is associated with childrearing techniques which emphasize the acceptance of authority (see Nash, pps. 282-283). Nash sums up her discussion by stating that "the cross-cultural evidence available to date is consistent with the hypothesis that child-rearing practice, and the social roles assigned the two sexes affect the degree to which the sexes differ in spatial ability (p. 282)."

In the present study our sample of high school seniors filled out the Parent Behavior Form (PBF, Worrell and Worrell, 1972) consisting of two sets of items which describe each parent's behavior from the perspective of the child. These items comprise 13 scales: warmth, active involvement, egalitarianism, cognitive independence, curiosity, cognitive competence, lax

control, conformity, achievement control, strict control, punitive control, hostile control, and rejection.

The 2 (Sex of Subject) x 3 (Space Group) x 2 (Sex of Parent) design allows us to make specific hypotheses about which effects we expect to find with each of these scales:

1. Those subscales that measure primarily affective parent behaviors were predicted to produce main effects of sex.

a. Warmth: It was predicted that mothers would be perceived to be warmer than fathers. It was also predicted that parents' warmth would vary as a function of the sex of the adolescent, although previous findings are equivocal in predicting the direction of this effect.

b. Active Involvement: A same-sex effect was predicted in keeping with the assumptions that same-sex parents become particularly salient to adolescents.

c. Egalitarianism: A sex of subject effect was predicted such that parents were expected to treat boys in a more egalitarian manner than girls.

d. Rejection: This scale was predicted to yield results opposite to those found with the warmth scale.

2. Cognitive Independence, Curiosity, Cognitive Competence (the parental cognitive influence dimension): A main effect of space group was predicted for these three cognitive scales. It should be noted that if we had randomly sampled from the normal distribution of spatial ability I would be predicting sex effects on these scales with parents encouraging

greater cognitive proficiency in boys than girls. The distribution of the present study leads to the prediction that these parental cognitive behaviors will relate primarily to the spatial ability of our adolescents rather than their sex.

3. Achievement Control: It was predicted that in keeping with societal sex-typing boys would perceive more pressure to achieve than would girls.

Subjects and Procedure

The instrument was filled out by a subsample of the already described sample. There was no differential return rate by sex or spatial group. There were, however, more questionnaires filled out about mothers (n = 103) than fathers (n = 98) as a function of family constellation.

Parent Behavior Form

The PBF described briefly above consists of two sets of 117 items which ask the adolescent to describe the parents' behavior. The respondent rates each descriptive statement as being "like", "somewhat like", or "not like" the parent at the time he was sixteen years old. The 13 PBF scales listed above each consist of 9 items. Factor analyses of PBF, have consistently revealed the presence of three orthogonal dimensions underlying the scales: parental warmth versus rejection, parental degree of control and parental cognitive influence (Worrell & Worrell, 1972). Alphas were computed for each of the 13 subscales. All of the subscales had alphas of above .80 with the exception of Cognitive Competence (.65), Lax Control (.72), Conformity (.50) and Achievement (.60) subscales.

Results

Separate 2 (Sex of Subject) x 3 (Space Group) ANOVAs were run on the adolescents' descriptions of their mothers and fathers on each of the 13 subscales. The hypotheses stated above differentiate between the parental warmth subscales which were expected to show sex effects and the cognitive subscales which were expected to show space group effect.

Sex effects

There was no support found for the affective behavior hypotheses stated above. The only sex effect found among the 26 ANOVAs performed was on the Achievement Control subscale.* In keeping with the hypothesis stated above, both fathers ($F = 4.96$; $p < .03$) and mothers ($F = 12.52$; $p < .001$) were perceived to encourage greater achievement by boys than by girls.

Space group effects

There also was no support found for the cognitive behavior hypotheses stated above. None of the three cognitive behavior subscales showed significant effects. There were, however, several interesting space group effects found with several of the affective behavior subscales. A main effect of space group was found on the Rejection subscale for both fathers ($F = 3.40$; $p < .04$) and mothers ($F = 3.72$; $p < .03$). The direction of the means indicated that low space adolescents saw their parents as more rejecting than did the medium or high space adolescents. The affective behavior subscales of Warmth, Active Involvement, and Egalitarianism also showed main effects

* While 1 to 2 significant effects can be expected by chance when 26 ANOVAs are run, these effects were predicted and are supported by previous studies.

of space group for mothers but not for fathers (See Figs. (1-4). Mothers were seen as warmer, more actively involved and more eqalitarian by high space adolescents than by medium or low space adolescents. The lack of cognitive behavior effects is surprising and may have been affected by the lower alpha levels found with these scales.

These findings indicated several interesting trends which were then explored in subsequent analyses. It seemed noteworthy that there were more effects found with the mother's behavior subscales than with the father's subscales. Secondly, an inspection of the means across the two separate sets of ANOVAs indicated sex of parent effects on a number of the subscales. In order to further evaluate these notions, a MANOVA was run on the differences between father and mother responses. The MANOVA findings parallel the findings on the ANOVA. The same effects are found with these differences scores indicating that mothers are perceived of differently than fathers by the space groups on the Rejection, Warmth, Active Involvement, and Egalitarianism subscales. Similarly, the main effect of sex of subject was found with the Achievement Control subscales indicating that mothers more than fathers were seen to encourage greater achievement for boys than girls.

Parent effects

Significant differences ($p < .01$) between mothers and fathers were found on eight of the 13 scales (see Table 1). The direction of means indicates again the perception of generally greater involvement on the part of the mothers than the fathers of our adolescents. Mothers were perceived not only to engage more frequently in the affective behaviors (Warmth,

Active Involvement, and Egalitarianism) than were fathers, but they were also perceived of as encouraging greater cognitive independence and competence as well as greater control over their children (as measured by the conformtiy and strict control subscales). They were also seen to exercise greater achievement control over their children than were the fathers.

Discussion

What have we learned about the relationship of parenting behavior to adolescents' sex and spatial ability? In the first place we found that when sex and spatial ability are unconfounded, there is little evidence for the differential treatment of the sexes by their parents. The only exception to this is sex effect found on the Achievement Control subscale. Thus, some of parent X sex interactions found in the literature may be mediated by spatial ability. Reasoning backwards from our stratified sample to a random sample of adolescents, the space group effects found for mothers on the affective behavior would be expected to produce sex effects such that mothers would be seen as warmer, more actively involved, and more egalitarian by boys than by girls. The greater warmth experienced in the mother-adolescent relationship by our high space group is not an effect of intelligence. While there was a relationship found between the Quick Test and spatial ability for boys, no such relationship was found for girls.

Our data indicate that high space adolescents enjoyed a warmer relationship with their mothers than did those lower in spatial ability. We can speculate that this present warm relationship is also indicative of the previous mother-child relationship. While it is not my goal here to discuss

the direction of these socialization effects, they are especially important to note as they are related to spatial ability rather than sex. While the socialization and identification hypotheses offered consider sex to be a relevant variable to which parents respond, little if any attention has been paid to some other child variables (such as physical attractiveness, intelligence, or verbal ability to name only a few) which may also elicit differential parental behaviors. Our data indicate that spatial ability may be one of these variables.

As indicated earlier, the child-rearing and socialization literatures have largely neglected the study of parent-adolescent interaction. Thus, our data provide some interesting information about the ways parents interact with their adolescent sons and daughters. The striking aspect of our data is the limited role the fathers of our adolescents are seen to play. Considering both the greater number of effects found with the mother behavior subscale as well as the sex of parent effects shown in Table 1, it is clear that mothers are the more salient parent in the lives of the adolescents we've studied. It should be stressed again, that this picture is viewed through the eyes of our adolescents as the data are the adolescents' perceptions of their parents rather than parental self-reports. While all this may not be surprising given the role mothers have traditionally played in the lives of their children, the fact that the role of the parents of adolescents remains stereotyped (even in the '80s) is certainly noteworthy.

The limited adolescent-father interactions reflected in our data have important implications for the future of gender-related role changes. As Baumrind (1980) emphasizes it has been recently suggested that "the subordinate position of females is perpetuated by family structure, by the fact that boys

and girls are reared predominantly by their mothers (p. 644)." We see evidence of predominant rearing by mothers with our adolescents. Future investigations with these data will seek to understand more fully the role mothering style may play with the other cognitive domains we have measured. We will also evaluate how other family variables such as family size, birth order, and working mothers may mediate these parenting effects.

Table 1 - Summary of the effects found with Parent Behavior Scale

	Effect Found		
ent Behavior Form Subscales[e]	Sex Effects	Space Group Effect	Parent Effect
Warmth		b	d
Active Involvement		b	d
Egalitarianism		b	d
Cognitive Independence			d
Curiosity			
Cognitive Competence			d
Lax Control			
Conformity			d
Achievement	a		d
Strict Control			d
Punitive Control			
Hostile Control			
Rejection		c	

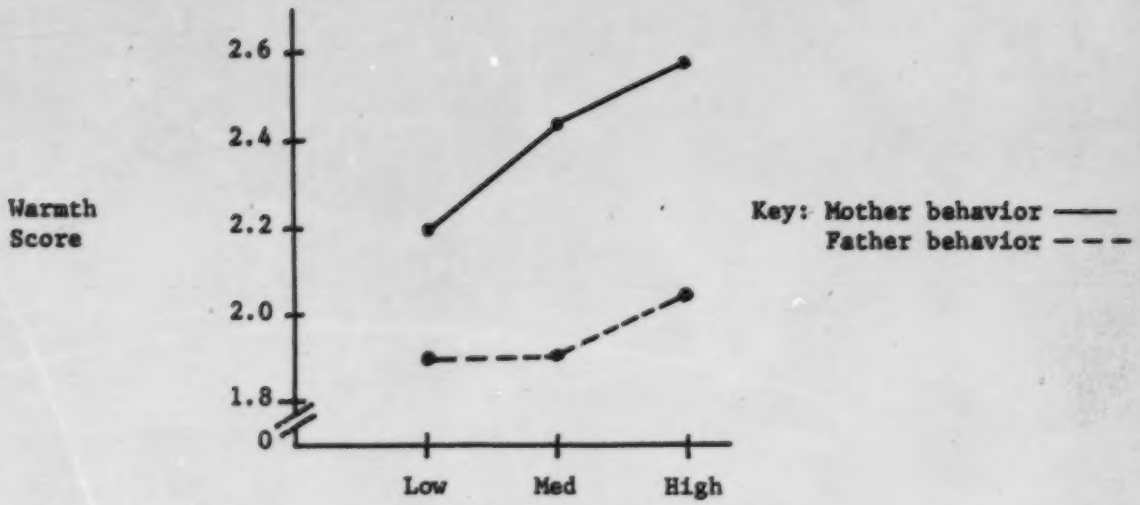
[a]Both fathers ($p < .03$) and mothers ($p < .001$) were perceived to encourage greater achievement by boys than by girls.

[b]Mothers were seen as warmer ($p < .02$), more actively involved ($p < .03$) and more egalitarian ($p < .004$) by high space than by medium or low space.

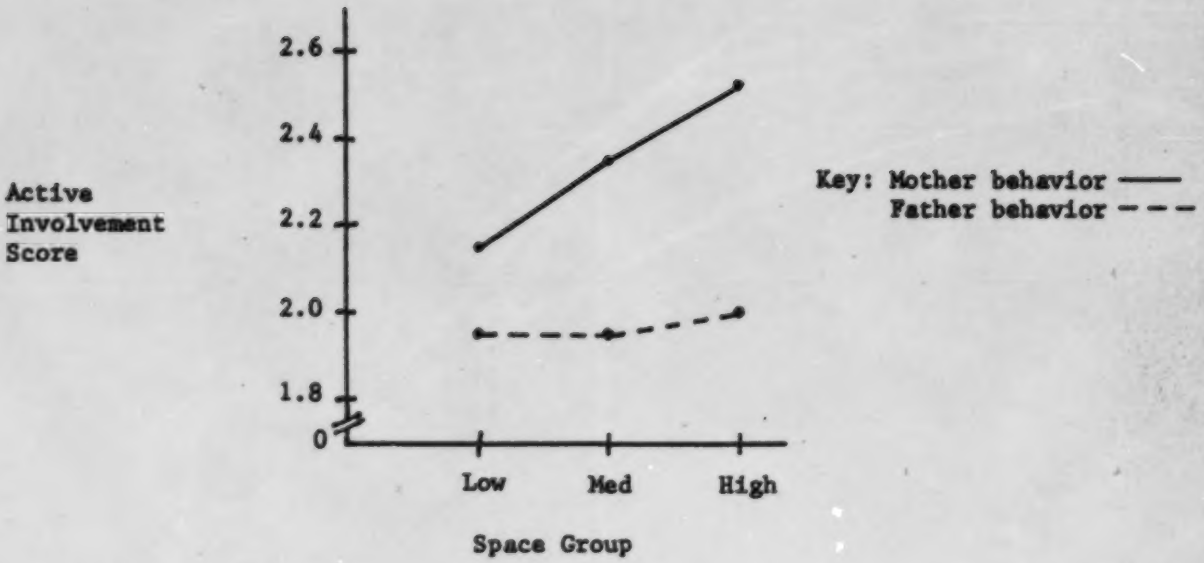
[c]Both fathers and mothers were seen as more rejecting by low space than by medium or high space ($p < .03$).

[d]Mothers were seen as exhibiting more of each of these qualities than father ($p < .01$).

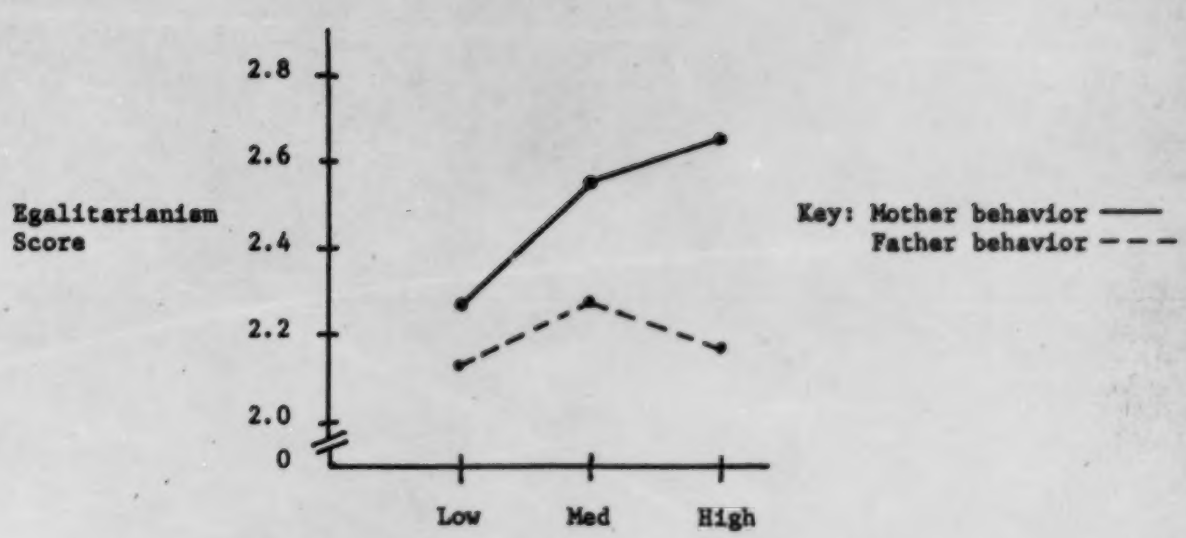
[e]The Parent Behavior Form was developed by Worell & Worell. Each subscale consists of 9 items.



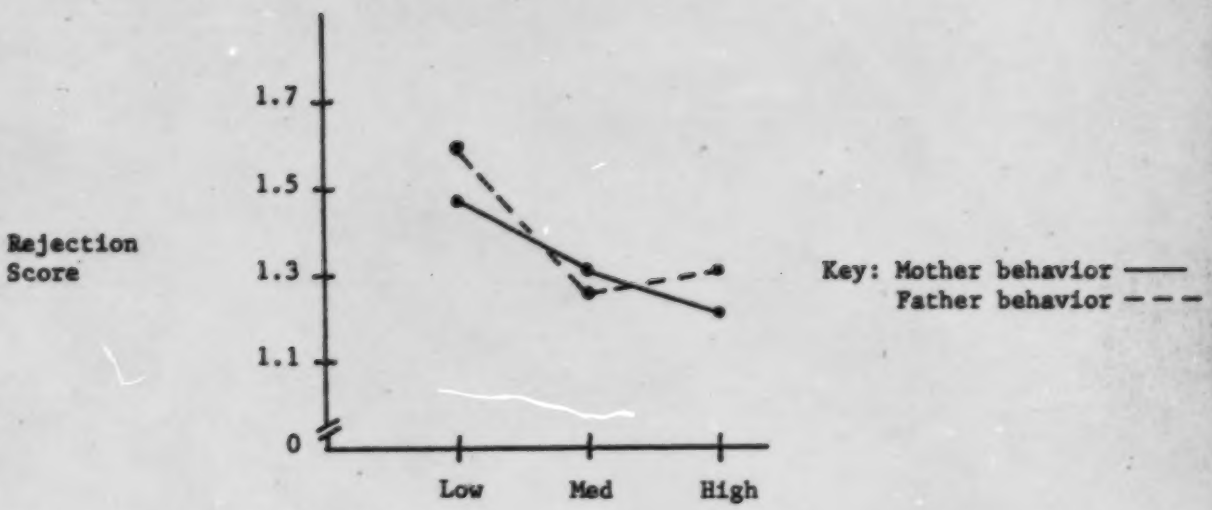
Mean Warmth Scores for mothers and fathers by space groups. Scale ranges from 1 to 3 with 3 representing the greatest warmth.



Mean Active Involvement for mothers and fathers by space group. Scale ranges from 1 to 3 with 3 representing the most active involvement.



Mean Egalitarianism Scores for mothers and fathers by space groups.
Scale ranges from 1 to 3 with 3 representing the most egalitarian behavior.



Mean Rejection Scores for mothers and fathers by space groups. Scale ranges from 1 to 3 with 3 representing the most rejection.

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The Influence of Experience and Sex Role Identity on Cognitive Performance

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The present paper will address the question of whether sex appropriateness of past and present activities and preferred courses relates to performance on a spatial task which tends to produce sex-related differences. Sex role identity will be considered as a mediating factor. Second, this paper will address the question of whether number of years of high school math and science relates to performance on the same spatial task.

Starting at a young age, the type of activities in which children participate consitutes a part of sex role socialization. Research indicates that preschoolers have already developed sex appropriate play preferences and that visual-spatial ability in boys relates to involvement in "masculine" activity (Conner & Serbin, 1977). Sex role stereotyping may influence the kind of activities chosen by generating set expectancies which exert pressure on individuals to act accordingly. Nash (1973), reviewing several studies of stereotyping within children, writes that from second to twelfth grade, children perceive certain skills as feminine and others, such as spatial ability, as masculine. From reviewing other research, Nash also reports that,

> Across age groups, significant correlations have been reported between the value one attaches to a particular area and one's task persistence, competence, and achievement level attained in that area...thus, at least for females, a higher value is placed on doing well in sex-appropriate areas of intellectual achievement, and these do predict their effort, and performance. (p.10)

Once these sex role stereotypes have had their influence, Nash writes that individual differences enter in the form of the individual's sex role identity to produce a particular kind of cognitive performance for each individual. This accounts for the fact that stereotypes do not have exactly the same impact on each person. Sex role identity is assumed by many in the cognitive sex differences literature to be the product of past sex role socialization. We hypothesize that sex role identity provides some sense of the individual's past and present socialization and cognitive organization as well as the influence of his or her physical androgyny. For example, research has shown that a person whose sex role orientation is feminine tends to do better with and is more willing to participate in an activity that is stereotypically feminine (Bem & Lenney, 1976; Bem, Martyna, & Watson, 1976).

Several studies have related spatial tasks to sex role identity, reporting that masculine and/or androgynous role identity tends to correlate with better performance on these types of tasks (Hyde, Geiringer, & Yen, 1975; Nash, 1975; Richards, Petersen & Gitelson, 1979).

The types of courses taken have also been hypothesized to relate to spatial performance. As with other activities, preference for masculine typed courses may relate to greater spatial ability. This preference may

be reflecting an overarching orientation toward education which may differ for girls and boys. Nash (1975) found that for boys, perceiving oneself as, and for girls, desiring to be, active, persistent, and interested in math and science, and disinterested in art and literature were associated with high spatial ability.

Course taking may also influence spatial ability by providing varying degrees of exposure an individual has to the kinds of problems involved as well as practice with problem solving techniques which are unique to spatial performance. Fennema and Sherman (1977) suggest that if differential course taking was controlled, differences in measures of aptitude and achievement reported in much of the literature might disappear.

It is hypothesized in this study that a linear relationship will emerge between spatial ability groups and participation in activities which are rated on a scale from traditionally feminine to traditionally masculine. The same relationship is expected between spatial ability group and course preference which has been similarly rated. Another hypothesis to be investigated in this paper is the relationship between number of semesters of high school math and science taken and spatial performance. Sex role identity was analyzed as a covariate, with the expectation that it might mediate between spatial ability and the sex typing of activities and course preference.

THE METHOD

The activity and course variables were developed out of questions asked during the interview. Each subject was asked what activities they

preferred doing, at which activities they considered themselves to be especially good, and at which they wished they could do better. They were also asked which junior high activities they recall doing. In order to determine their course preference they were asked what two courses they like best and least in high school and what one best and least in junior high.

The gender specificity of these activities and courses was determined through ratings done by a panel of judges. The panel was instructed to rate the list of activities and courses according to how traditionally feminine, neutral, or masculine the society at large might view them. Each course and activity was recoded to equal the mean of the above ratings so that a code of one means the rating was totally feminine and a three the rating totally masculine, with neutral being a two. The recoded answers were then summed and divided by the number of courses or activities mentioned by each person to create the four activity and two course variables mentioned earlier.

The respondents were asked also the number of semesters of math and science they had taken during high school. The codes go from one to eight and equal the number of semester-courses an individual took including those taken during the senior year.

Sex role orientation was measured with the Bem Sex Role Inventory (BSRI) and scored to produce four scales: masculinity, femininity, androgyny, and social desirability. A respondent indicates on a seven point scale how well each of 20 masculine, 20 feminine, and 20 neutral persona-

lity characteristics (in the form of adjectives) describes him or herself. The masculinity score equals the mean self-rating for all endorsed masculine items and femininity equals the mean self-rating for all endorsed feminine items. The androgyny score is derived through a t-ratio, that is the difference between an individual's femininity and masculinity scores adjusted to reflect individual variance. Therefore, the greater the absolute value of the androgyny score, the more sex typed or sex reversed, with high positive scores indicating masculinity and high negative scores indicating femininity (Bem, 1974).

THE RESULTS

The same design for analyzing the variables as presented in the preceding papers was employed in this one. The dependent measures consist of the activity and course variables, with sex role identity as a covariate.

The results indicate that sex role identity does not mediate between spatial performance and the dependent measures. Therefore, it was eliminated from further analyses. The multivariate analysis of variance produced results which are largely inconsistent with the hypothesis. There are no significant differences by spatial group. Trends in the expected direction only appear for the males on the course preference variables and for females with junior high activities. The one consistent and significant difference that is found across variables is that produced by sex. The Multivariate F value = 11.40, $p < .001$. (look at Figure 1). Males, more than females, prefer to do, do well and would like to do better at, activities which are viewed as more masculine. This difference is large with Univariate F-values consistently exceeding 30 ($p < .0001$).

The activities which the seniors preferred doing during junior high school produced similar results with a sex difference in the expected direction ($F = 7.03$, $p < .01$). Females recalled doing feminine activities more than did males.

Including junior high and high school in one measure, the sex appropriateness of most liked and disliked courses varied by sex too, although the latter, most disliked, was not significant. Most liked courses produced an F-value of 11.88 ($p < .001$) while most disliked produced an F of 3.39 ($p < .07$). Once again these differed by sex in the expected direction.

A significant interaction emerges between sex and spatial group when the number of semesters of math and science are considered. These are displayed in Figure 2 and Figure 3. For the boys, high spatial group has taken the greatest number of terms of both subjects followed by the medium and then the low. For girls, the sequence is different with the medium spatial group having taken the greatest number, next the high, and then the low.

DISCUSSION

Our hypotheses were not supported by these results. Expecting to find sex appropriateness of activities and course preferences to vary by spatial group, we find instead that they vary by sex. Considering the design of the study where boys and girls were selected for equal spatial ability, and therefore where sex should not be a confounding variable, these findings support rather strongly the null hypothesis, that sex appropriateness of past and present activities and course preference is

not associated with spatial performance. These findings bring to question the underlying mechanism posited to explain sex differences in spatial ability, that is the notion that sex-appropriateness of activities and courses influences degree of motivation, interest, energy spent, and therefore proficiency in certain tasks which are sex-typed.

The large and consistent sex difference between kinds of activities and courses that high school seniors do and prefer is both surprising and not surprising. It is not surprising in that one would expect females to engage in and enjoy feminine activities and males to engage in and enjoy masculine activities. The results also provide a test of validity; the strong association indicates that the variables are measuring what they were designed to. The large sex difference is surprising in that with the current emphasis on androgynous lifestyles and the expressed desire, by at least a portion of society, to move toward greater sexual equality, I would not have expected as large a difference. This expectation of minimal sex differences also stems from the conclusions of Maccoby and Jacklin's (1974) review of the sex differences literature. Sex differences are deemphasized in their findings.

The interaction between sex and spatial group is consistent across the two variables measuring number of semester-courses of math and science. For boys the high spatial group took more courses of both subjects with a significant difference between high and low groups appearing for math ($F = 10.07$, $p < .01$). This provides some support for the argument that spatial ability is a more salient construct for boys than girls. It organizes in a linear fashion other aspects of cognition, personality, and behavior more often for boys than girls.

In conclusion, the findings do not support the hypothesis that sex role socialization in the form of activities and course preference is associated with spatial ability. One problem arises in the analysis of these variables. It is assumed that individuals would tend to engage in either feminine or masculine behavior exclusively. In reality it may be an androgynous choice of activities and courses which relates to spatial performance. It has been pointed out numerous times that masculinity and femininity do not necessarily form a unidimensional scale (Bem, 1974; Spence & Helmreich, 1978), and that individuals can simultaneously be high or low on both. The next question to ask of these data is whether individuals who do both masculine and feminine activities are also the ones who perform well on spatial tasks.

Another way to approach the question of socialization through activities and courses is to code them according to spatial component. Newcombe, Bandura, and Taylor (1980) developed a scale to measure spatial experience of adolescents. They found that participation in the activities on the scale correlated with spatial ability. Another next step with our data is to code the activities according to their spatial salience and then investigate the relation between this and spatial performance. Two of the interviewers noticed several of their high space girls involved and interested in the subject of art. The fine arts, being both a spatial and sex appropriate field, may be an activity in which girls can learn and express spatial proficiency. These questions and others remain to be addressed in the future.

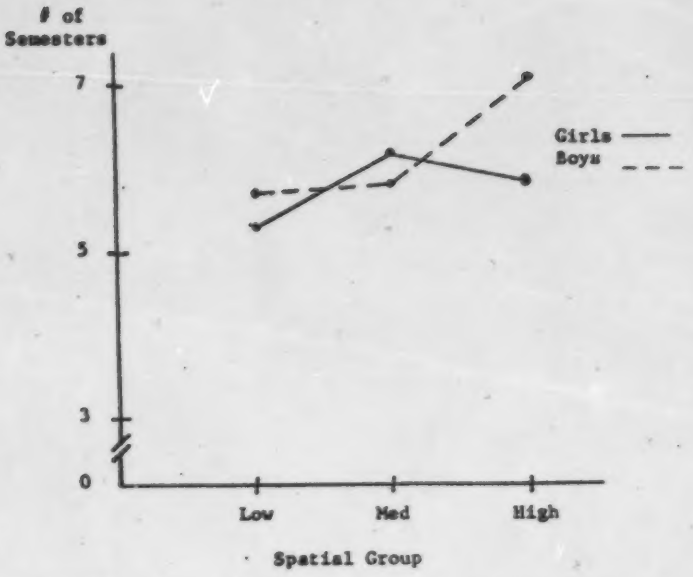

Figure 2: Number of Semester-Courses of Math Taken By Sex and Spatial Group

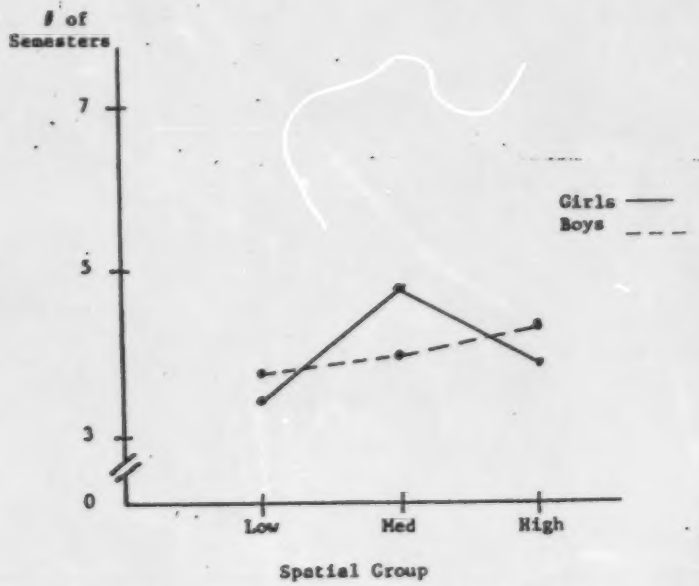

Figure 3: Number of Semester-Courses of Science Taken By Sex and Spatial Group

Figure 1:

Means, Standard Deviations, and F-Values for Activity and Course Preference Variables By Sex

Variables*	Sex			
	Males	Females	Univariate F's	p less than
Courses Liked	2.09(.49)	1.79(.50)	11.88	.0008
Courses Disliked	-2.06(.61)	-2.26(.56)	3.39	.07
Present Activities	2.14(.24)	1.89(.22)	40.85	.0001
Activities Good At	2.10(.38)	1.72(.32)	40.03	.0001
Activities Hope To Do Better At	2.10(.36)	1.76(.31)	37.23	.0001
Junior High Activities	1.85(.30)	1.73(.24)	7.03	.009

* These scales were developed by weighting the courses and activities according to how masculine or feminine they were judged to be. The gender specificity was determined through ratings done by a panel of judges. A three represents a completely masculine judgement and a one a completely feminine one.

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Timing of Maturation, Brain Lateralization and Cognitive Performance

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This presentation will address two questions. First, is timing of maturation related to spatial ability? Second, if there is an association between timing and spatial ability, does brain lateralization mediate the relationship?

Maccoby and Jacklin (1974) noted that reports of a sex-related difference in spatial ability began to appear with young adolescents and became increasingly consistent with age. In 1976, Waber proposed that timing of pubertal maturation explains both the sex difference and the timing of its appearance. She further suggested that brain lateralization is the mechanism by which timing influences cognitive performance. Waber proposed that brain lateralization continued until curtailed by the termination of pubertal growth. Since the maturation of boys is about two years later than that of girls, they have two additional years for further lateralization of function in their brains. Waber's results supported these hypotheses. Later maturing boys and girls were better spatial visualizers and were more lateralized.

While Waber's hypothesis is appealing, it has not yet been replicated. Petersen (1976) found no significant association between timing of maturation

and spatial performance in longitudinal data obtained at 13, 16, and 18 years of age. (Indeed, 5 of the 6 correlations were negative). Herbst and Petersen (1979) again found insignificant but negative associations in a sample of adolescent girls.

METHODS

In this presentation we will examine the relations of sex and spatial ability group to timing of maturation and handedness, the latter as a proxy for brain lateralization. In addition, we present preliminary results on a dichotic listening task as a measure of brain lateralization.

Timing of maturation was measured by age at menarche in girls and age at most rapid growth in boys. The means and standard deviations for these variables are shown in Table 1. Age at menarche is similar to that reported in other studies (Herbst & Petersen, 1979; Zacharias, Wurtman, & Schatzoff, 1976). Age at peak growth reported by girls (12.3 years) was overestimated, based on other data (e.g., Bock, Wainer, Petersen, Thissen, Murray, & Roche, 1973). Boys' reports of peak growth appear reasonable, however. We speculate that girls may remember menarche more accurately than peak growth whereas for boys, peak growth is a memorable event. The correlation between age at menarche and age at peak growth was only .41, far below the .77 obtained in previous research (Petersen, 1979) where height was measured semiannually. Thus, we decided to use menarche for girls and peak growth for boys in subsequent analyses.

Handedness was measured with the Edinburg Inventory which asks for an assessment of hand generally used (reported with a five-level response scale) for twelve common activities such as writing, opening a lid, dealing cards, etc. (Oldfield, 1971).

We utilized a dichotic listening task involving phoneme recognition, since this task most predictably shows sex difference (Harshman, Remington & Krashen, 1976). We are grateful to Dr. Sheri Berenbaum for conducting this part of our study for us. The stimuli were six consonant-vowel syllables presented in pairs, one to each ear. There were four blocks of 30 presentations for a total of 120 trials. Data were scored in several ways; we will present results from three commonly used scoring methods: mean ear advantage (A), absolute ear advantage (|A|), and a score considering overall accuracy and ear advantage (F).

RESULTS

Timing of maturation and brain lateralization were examined in a sex by space group multivariate analysis of variance. The means and standard deviations are shown in Table 1. There was no main effect for sex[1]. There was a main effect for space group in the comparison of high versus low groups ($F=89$, $p < .02$). This multivariate effect appears to be due to the maturation variable. Those with high spatial ability tend to be later maturers than those with low spatial ability. Handedness appears to be unrelated to either sex or spatial ability. An analysis of familial handedness produced similar results.

Table 2 shows the means and standard deviations by group on the dichotic listening task scores. There are no sex effects or space group effects. There was, however a significant multivariate interaction effect ($F=3.70$, $p < .01$) that seems primarily due to an independent contribution of the absolute value of the mean ear advantage. In our sample, medium space boys show the highest scores on this variable. This is not an effect explicable

[1] Menarche (girls) and age at peak growth (boys) did differ in a univariate test, a meaningless result since these are different variables.

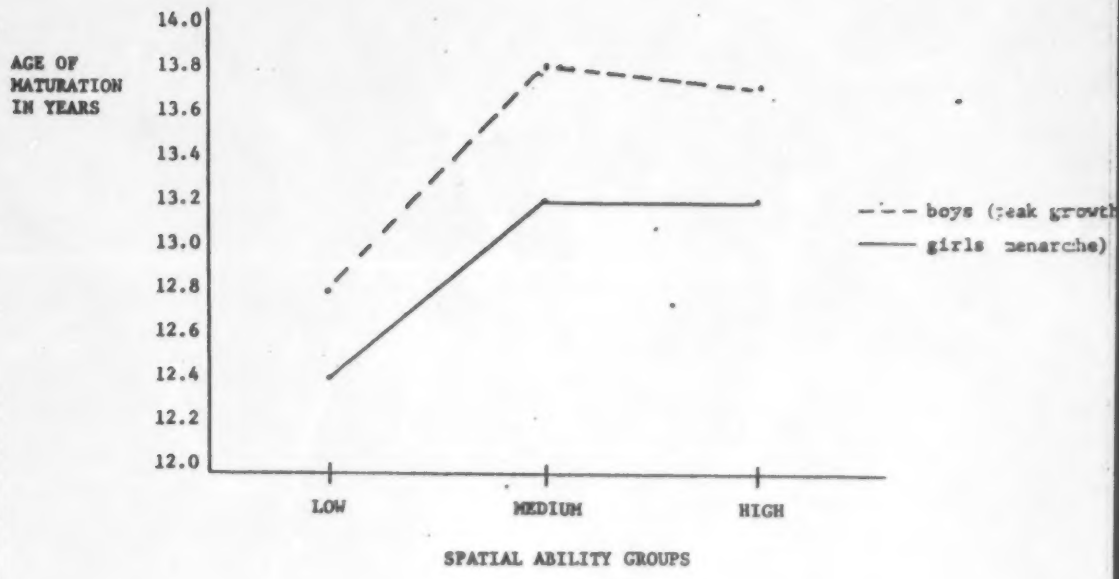
by any substantive hypothesis. This result will need to be explored further.

DISCUSSION

Our results replicate Waber's finding of an association between spatial ability and timing of maturation. We do not find support for mediation of this relationship by brain lateralization.

The difference between our current and previous results may be explained by sampling differences. In the present study, as well as in Waber's research, extreme groups (based on spatial ability and timing of maturation the two studies, respectively) were sampled. This oversampling of the tails of the distributions has the effect of emphasizing an association, if it exists. In samples that are normally distributed for spatial ability or timing of maturation the effect is too weak to emerge.

Our dichotic listening data are preliminary and require further checking. Hence, we are not yet ready to infer that brain lateralization is not the mechanism by which timing of maturation is related to spatial ability. Sherman's (1967) "bent twig" hypothesis may be the appropriate way to understand the relationship. We prefer this hypothesis as it allows for the influence of sex-related experiences on brain lateralization and spatial ability. Alternatively, the mechanism may be primarily biological as Witelson (1976), and others have suggested.



TIMING OF MATURATION BY SPATIAL ABILITY GROUPS AND SEX

TABLE 1

Means and Standard Deviations of Biological Measures
by Sex and Spatial Ability

	Spatial Ability Groups					
	Low		Medium		High	
	M	F	M	F	M	F
Timing of Maturation	12.8(2.1)	12.4(0.9)	13.8(1.6)	13.2(1.3)	13.7(1.4)	13.2(0.8)
Handedness	4.0(1.0)	4.1(1.2)	4.3(0.9)	4.3(0.6)	3.8(1.0)	4.2(0.9)

Timing of Maturation is measured in years.

Handedness is measured on a continuous scale ranging from always left (1) to always right (5).

Table 2

Means and Standard Deviations for
Three Dichotic Listening Scores

	Space Groups					
	Low		Medium		High	
Score*	M	F	M	F	M	F
A	4.6 (6.6)	4.4 (10.1)	7.3 (10.4)	5.8 (7.5)	3.6 (9.5)	4.1 (5.8)
|A|	5.6 (5.8)	7.9 (7.9)	9.9 (7.8)	7.3 (5.9)	7.1 (7.0)	6.0 (3.7)
F	53.2 (4.2)	53.6 (8.9)	56.2 (8.4)	54.4 (6.7)	52.6 (5.9)	52.8 (4.9)

*A is (R-L)/(R+L) x 100 where R is the number correct in the right ear and L is the number correct in the left ear.

|A| is the absolute value of A

F is POE if the overall accuracy is less than 50% and POC if accuracy exceeds 50%. POE is the percent errors in the left ear. POC is the percent correct in the right ear.

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Summary Remarks

Anne C. Petersen

I would like to conclude our presentations with a brief summary of our findings as well as an indication of our next steps in this study.

Summary

Anita, in her presentation, reported that scores on the physical mathematical reasoning measure were related to spatial ability group. This is a finding that we have obtained in other studies; most measures of formal operational thought appear to require spatial capacity. This result supports our hypothesis that the sex difference in some tasks measuring formal operations is confounded with, and may be due to, the sex difference in spatial ability.

As in this presentation, we have previously found a sex difference in ego development. We have not, however, seen this result reported in the literature. We do not think that this result is due to our sampling design, since ego development is unrelated to spatial ability.

Idy, in the next presentation, reported that some affective parent behaviors were related to spatial ability groups. There was no evidence, however, of differential parental socialization of boys compared to girls.

Maryse, in her presentation reported that the Femininity and Androgyny

scores on the BSRI are related to space groups but Masculinity was unrelated. There was no evidence, however, that sex-typed activities were related to space groups.

Lee, in the last presentation, reported that later maturation was related to higher spatial ability, replicating Waber's research. No support was found, however, for the possibility of this effect operating through brain lateralization.

Discussion

How do these results support our hypothetical model for sex differences in spatial ability? Neither developmental variables nor parental socialization factors appear to be explanatory. There is some evidence of a sex role effect, though this effect is not related to sex-typed activities. There is also some evidence for an effect of timing of maturation, though this effect is unrelated to the hypothesized mechanism of brain lateralization. We will next examine if sex role orientation and timing of maturation have any joint associations. In addition, we plan to examine strategy effects. We measured several other biological variables that are unanalyzed as yet. We also plan to study the relation of involvement in spatially-related activities to spatial performance. Our ultimate goal is to revise our current model for sex differences in cognitive performance, integrating effects across the areas of biological, psychological, and social influences. We hope to understand what the sex difference represents and how it develops.